

TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C. 371

010456
U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR 1.5)
09/807947

INTERNATIONAL APPLICATION NO.
PCT/DE99/03362INTERNATIONAL FILING DATE
16 October 1999PRIORITY DATE CLAIMED
21 October 1998

TITLE OF INVENTION

Integrated Polycrystalline Silicon Resistor with Carbon or GermaniumAPPLICANT(S) FOR DO/EO/US
MEHR, Wolfgang

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (24) indicated below.
4. The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
 - a. is attached hereto (required only if not communicated by the International Bureau).
 - b. has been communicated by the International Bureau.
 - c. is not required, as the application was filed in the United States Receiving Office (RO/US).
6. An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
 - a. is attached hereto.
 - b. has been previously submitted under 35 U.S.C. 154(d)(4).
7. Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
 - a. are attached hereto (required only if not communicated by the International Bureau).
 - b. have been communicated by the International Bureau.
 - c. have not been made; however, the time limit for making such amendments has NOT expired.
 - d. have not been made and will not be made.
8. An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
10. An English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).
11. A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. A copy of the International Search Report (PCT/ISA/210).

Items 13 to 20 below concern document(s) or information included:

13. An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. A **FIRST** preliminary amendment.
16. A **SECOND** or **SUBSEQUENT** preliminary amendment.
17. A substitute specification.
18. A change of power of attorney and/or address letter.
19. A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
20. A second copy of the published international application under 35 U.S.C. 154(d)(4).
21. A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
22. Certificate of Mailing by Express Mail
23. Other items or information:

a Assignee's Small Entity Status Certificate

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR 1.60)	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NUMBER																								
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24. The following fees are submitted:																										
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :																										
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Surcharge of \$130.00 for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).																										
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<table border="1"> <thead> <tr> <th>CLAIMS</th> <th>NUMBER FILED</th> <th>NUMBER EXTRA</th> <th>RATE</th> </tr> </thead> <tbody> <tr> <td>Total claims</td> <td>2 - 20 =</td> <td>0</td> <td>x \$18.00</td> </tr> <tr> <td>Independent claims</td> <td>2 - 3 =</td> <td>0</td> <td>x \$80.00</td> </tr> <tr> <td colspan="2">Multiple Dependent Claims (check if applicable)</td> <td></td> <td style="text-align: right;">\$0.00</td> </tr> </tbody> </table>			CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	Total claims	2 - 20 =	0	x \$18.00	Independent claims	2 - 3 =	0	x \$80.00	Multiple Dependent Claims (check if applicable)			\$0.00								
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<input checked="" type="checkbox"/> Applicant claims small entity status. (See 37 CFR 1.27). The fees indicated above are reduced by 1/2.																										
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Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) (check if applicable).																										
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a. <input checked="" type="checkbox"/> A check in the amount of <u>\$430.00</u> to cover the above fees is enclosed. b. <input type="checkbox"/> Please charge my Deposit Account No. _____ in the amount of _____ to cover the above fees. A duplicate copy of this sheet is enclosed. c. <input type="checkbox"/> The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. _____ A duplicate copy of this sheet is enclosed. d. <input type="checkbox"/> Fees are to be charged to a credit card. WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.																										
NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.																										
SEND ALL CORRESPONDENCE TO:																										
Law Offices of Karl Hormann 86 Sparkle Street Cambridge MA 02138-2216		 SIGNATURE Karl Hormann NAME 26,470 REGISTRATION NUMBER 20 April 2001 DATE																								

IN THE UNITED STATES PATENT & TRADEMARK OFFICE

International Application No.: PCT/DE99/03362

International Filing Date: 16 October 1999

Inventor: Mehr, Wolfgang

For: Integrated Polycrystalline Silicon Resistor
with Carbon or Germanium

86 Sparks Street
Cambridge MA 02138-2216
19 April 2001

Hon.
Assistant Commissioner for Patents
Washington DC 20231

Box PCT

Preliminary Amendment

Sir:

With a view to placing the English translation of his instant International Application as annexed to the International Preliminary Examination Report into a form believed to satisfy current U.S. patent prosecution standards, Applicant courteously requests that the following amendment be entered into the application.

In the Specification:

Page 1, line 7: insert --BACKGROUND OF THE INVENTION.--;

line 8: insert --1. Field of the Invention.--

line 11: insert --2. The Prior Art.--;

page 2, line 8: insert --OBJECTS OF THE INVENTION.--;

line 15: insert --BRIEF SUMMARY OF THE INVENTION.--;

page 3, line 24: insert --DESCRIPTION OF THE DRAWING.--;

line 27: insert --DETAILED DESCRIPTION OF THE INVENTION.--;

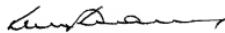
page 5, line 1: cancel "Patent Claim" and substitute --What is claimed is:--

therefor;

line 3: change "Integrated" to --An integrated--; and

line 9: change "Method" to --A method--.

Respectfully submitted,

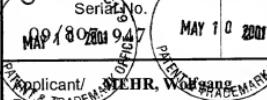


Karl Hormann
Registration No.: 26,470

Area Code 617.491.8867

**VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL ENTITY
STATUS (37 CFR 1.70 AND 1.27 (c)) - SMALL BUSINESS CONCERN**

Docket No.
010456

Serial No. 09/180,204 filed MAP 10 2001 April 2001	Filing Date MAY 10 2001 April 2001	Patent No.	Issue Date
 Applicant/ Patentee: MEHR, WOLFGANG			
<p>Invention: Integrated Polycrystalline Silicon Resistor with Carbon or Germanium</p>			

I hereby declare that I am:

the owner of the small business concern identified below:
 an official of the small business concern empowered to act on behalf of the concern identified below:

NAME OF CONCERN: **IHP GmbH. Innovations for High Performance Microelectronics Institut fuer innovative....**

ADDRESS OF CONCERN: **Im Technologiepark 25, D-15236 Frankfurt (Oder), Germany**

I hereby declare that the above-identified small business concern qualifies as a small business concern as defined in 37 CFR 121.3-18, and reproduced in 37 CFR 1.9(d), for purposes of paying reduced fees under Section 41(a) and (b) of Title 35, United States Code, in that the number of employees of the concern, including those of its affiliates, does not exceed 500 persons. For purposes of this statement, (1) the number of employees of the business concern is the average over the previous fiscal year of the concern of the persons employed on a full-time, part-time or temporary basis during each of the pay periods of the fiscal year, and (2) concerns are affiliates of each other when either, directly or indirectly, one concern controls or has the power to control the other, or a third party or parties controls or has the power to control both.

I hereby declare that rights under contract or law have been conveyed to and remain with the small business concern identified above with regard to the above identified invention described in:

the specification filed herewith with title as listed above.
 the application identified above.
 the patent identified above.

If the rights held by the above-identified small business concern are not exclusive, each individual, concern or organization having rights to the invention is listed on the next page and no rights to the invention are held by any person, other than the inventor, who could not qualify as an independent inventor under 37 CFR 1.9(c) or by any concern which would not qualify as a small business concern under 37 CFR 1.9(d) or a nonprofit organization under 37 CFR 1.9(e).

Each person, concern or organization to which I have assigned, granted, conveyed, or licensed or am under an obligation under contract or law to assign, grant, convey, or license any rights in the invention is listed below:

no such person, concern or organization exists.
 each such person, concern or organization is listed below.

FULL NAME

ADDRESS

Individual Small Business Concern Nonprofit Organization

FULL NAME

ADDRESS

Individual Small Business Concern Nonprofit Organization

FULL NAME

ADDRESS

Individual Small Business Concern Nonprofit Organization

FULL NAME

ADDRESS

Individual Small Business Concern Nonprofit Organization

Separate verified statements are required from each named person, concern or organization having rights to the invention averring to their status as small entities. (37 CFR 1.27)

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28(b))

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

NAME OF PERSON SIGNING:

TITLE OF PERSON SIGNING

OTHER THAN OWNER:

ADDRESS OF PERSON SIGNING:

SIGNATURE:

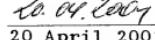


Prof. A. Ourmazd
Scientific Director



F. Weinl
Adm. Director

DATE:


20 April 2001

VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL ENTITY STATUS (37 CFR 1.9(f) AND 1.27 (c)) - SMALL BUSINESS CONCERN				Docket No. 010456
Serial No.	Filing Date 20 April 2001	Patent No.	Issue Date	
Applicant/ MEHR, Wolfgang Patentee:				
Invention: Integrated Polycrystalline Silicon Resistor with Carbon or Germanium				
I hereby declare that I am: <input type="checkbox"/> the owner of the small business concern identified below; <input checked="" type="checkbox"/> an official of the small business concern empowered to act on behalf of the concern identified below;				
NAME OF CONCERN: IHP GmbH. Innovations for High Performance Microelectronics Institut fuer innovative... ADDRESS OF CONCERN: Im Technologiepark 25, D-15236 Frankfurt (Oder), Germany				
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I hereby declare that rights under contract or law have been conveyed to and remain with the small business concern identified above with regard to the above identified invention described in: <input checked="" type="checkbox"/> the specification filed herewith with title as listed above. <input type="checkbox"/> the application identified above. <input type="checkbox"/> the patent identified above.				
If the rights held by the above-identified small business concern are not exclusive, each individual, concern or organization having rights to the invention is listed on the next page and no rights to the invention are held by any person, other than the inventor, who could not qualify as an independent inventor under 37 CFR 1.9(c) or by any concern which would not qualify as a small business concern under 37 CFR 1.9(d) or a nonprofit organization under 37 CFR 1.9(e).				

Each person, concern or organization to which I have assigned, granted, conveyed, or licensed or am under an obligation under contract or law to assign, grant, convey, or license any rights in the invention is listed below:

- no such person, concern or organization exists.
- each such person, concern or organization is listed below.

FULL NAME

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

NAME OF PERSON SIGNING:

Karl Hormann

TITLE OF PERSON SIGNING

OTHER THAN OWNER:

ADDRESS OF PERSON SIGNING:

Attorney for the Assignee

86 Sparks Street

Cambridge, MA 02138-2216

SIGNATURE:


DATE: 20 April 2001

5

**Integrated Polycrystalline Silicon Resistor
with Carbon or Germanium**

The invention relates to an integrated high ohmic polycrystalline silicon
10 resistor and to a method of its fabrication.

In microelectronics integrated resistors are being used in analog as
well as in digital circuits or control circuits. These resistors are to posses the
lowest possible tolerances and a high stability. Resistors based upon
15 polycrystalline materials are a particularly cost-efficient variant, but for many
applications high ohmic resistors in particular do not attain sufficient values of
stability and tolerance.

In integrated circuits, semiconductor resistors are used because of
20 their compatibility with conventional technological methods of fabrication and
because of relatively simple possibilities of variation as, for instance, by
doping. Amorphous as well as polycrystalline semiconductor layers, silicon in
particular, are used as the basic material. Resistance properties such as, for
instance, resistance value, resistance tolerances and temperature stability are
25 essentially determined by the geometric dimensions of the resistance layer,
by the basic material used, by the doping elements, the doping method
applied, by the doping concentration and by the ensuing processes, above all
by the temperature/time stresses arising in connection therewith.

30 Because of their grain structure, problems of stability arise in high
ohmic polysilicon layers. These are caused in particular by the out-diffusion

of the dopants from the monocrystalline areas, the segregation of the dopants at the grain boundaries, the attachment of charge carriers in deep traps of the corn boundaries as well as by the formation of potential barriers at the corn boundaries associated therewith. The increase in resistance tolerance

5 resulting therefrom, particularly by the temperature/time stress in ensuing process steps, and in the temperature coefficient leads to limitations in the application of high-ohmic polycrystalline resistors.

It is the task of the invention to propose an integrated high-ohmic

10 polycrystalline silicon resistor and a method of its fabrication, in which the sensitivity to tolerances during the fabrication process and, hence, the resistance tolerance value are improved and the temperature coefficient is reduced relative to conventional resistors of this kind. Furthermore, it is a task of the invention to raise the stability of such resistors.

15

This task is accomplished, in accordance with the invention, by reducing the diffusion or the diffusion coefficient of the doping elements within the monocrystalline grains by the incorporation of carbon and/or by the use of polycrystalline SiGe with or without the addition of carbon.

20

In this manner it is possible to fabricate high-ohmic polysilicon resistors, having, in particular, resistance layer thicknesses $R_s \geq 10^3 \Omega/\square$ with improved values of tolerance and stability.

25

A precipitation of $Si_{1-y}C_y$ or SiGeC is used, instead of the hitherto conventional precipitation of pure and usually amorphous or polycrystalline Si layers followed by implantation and annealing or *in situ* doping with doping elements such as, for instance, boron, phosphorus, arsenic or antimony.

30

In this connection use is being made of the effect that adding carbon leads to a reduction of the diffusion coefficient of the doping elements, in

particular of boron, and thus to a reduction or prevention of the segregation effects at the grain boundaries or of the out-diffusion of the doping elements from the monocrystalline areas. This results in stabilization of the potential barrier and thus leads to a reduction in the temperature dependency of the 5 resistor.

The use of SiGe as a basic material also leads to reduced temperature dependency.

10 The addition of carbon and/or germanium to the silicon may be carried out, for instance, *in situ* or by implantation followed by annealing.

The above-mentioned effects are improved by combining the two additives as a SiGe layer.

15 It is thus possible by the described method to fabricate high-ohmic polycrystalline silicon resistors with reduced temperature coefficients, increased stability and improved tolerance values.

20 Aside from the claims the characteristics of the invention are also apparent from the specification and drawings, the individual characteristics by themselves or in any combination constituting protectible embodiments for which protection is being sought here.

25 An embodiment of the invention is presented in the drawing and will be described in greater detail hereinafter.

Fig. 1 schematically depicts the structure of an integrated polycrystalline resistor. The resistor in accordance with the invention consists 30 of a substrate 1, a dielectric substance 2, a doped polycrystalline layer 3 and metallic contacts 4. The polycrystalline layer 3 may consist of SiGeC, but

$\text{Si}_{1-y}\text{C}_y$ or SiGe also lie within the ambit of the invention. The geometric dimensions and the doping of the polycrystalline layer 3 depend upon the resistance value to be achieved.

5 For purposes of fabrication, a dielectric substance 2 is precipitated on a substrate 1. This is followed by precipitation and structuring of the polycrystalline or still amorphous layer 3. In addition to boron doping, carbon and/or germanium is added to the silicon *in situ* or by implantation and subsequent annealing. The concentration of boron, carbon and germanium
10 also depend upon the resistance value to be achieved. This is followed by a further precipitation of the dielectric substance 2 and by the fabrication of the metallic contacts 4.

In connection with the present invention, an integrated high-ohmic
15 polycrystalline silicon resistor and a method of its fabrication have been described on the basis of a concrete embodiment. It is, however, to be noted that the present invention is not limited to details of the embodiment described, since alterations and mutations are being claimed within the scope of the claims.

20

25

30

Patent Claims

1. Integrated high-ohmic polycrystalline silicon resistor comprising a substrate (1), a dielectric substance (2), a resistance layer and contacts (4), the resistance layer consisting of a polycrystalline layer (3) of SiGe:C and the polycrystalline layer (3) being doped with doping elements, in particular boron or phosphorus.
2. Method of fabricating an integrated high-ohmic polycrystalline silicon resistor of claim 1, characterized by the method steps of:
 - precipitating a dielectric substance (2) on a substrate (1), in particular a silicon wafer,
 - forming a polycrystalline layer (3) of SiGe:C, the polycrystalline layer (3), the polycrystalline layer (3) being carried out by *in situ* precipitation of SiGe:C or implantation of Si with Ge:C followed by annealing, *)
 - doping the polycrystalline layer (3) with doping elements, in particular boron or phosphorus;
 - further precipitation of the dielectric substance (2) and fabricating the metallic contacts (4).

20

*) Something is amiss in this section of the German claim. It should (in English translation) correctly state: "...,the formation of the polycrystalline layer (3) being carried out...." (Translator's note).

25

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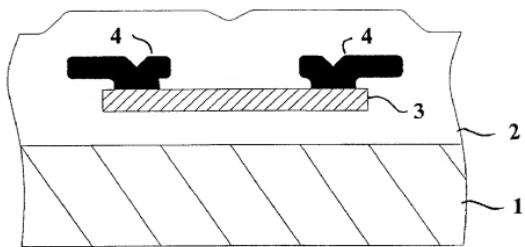
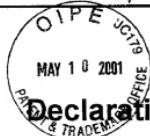


Fig. 1

Docket No.
010456

Declaration and Power of Attorney For Patent Application

A English Language Declaration

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

Integrated Polycrystalline Silicon Resistor with Carbon or Germanium

the specification of which

(check one)

is attached hereto.

was filed on 20 April 2001 as United States Application No. or PCT International

Application Number 09/807,947

and was amended on _____

(if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d) or Section 365(b) of any foreign application(s) for patent or inventor's certificate, or Section 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate or PCT International application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s)		Priority Not Claimed
198 49 471.8	Germany	<input type="checkbox"/>
(Number)	(Country)	<input type="checkbox"/>
(Number)	(Country)	<input type="checkbox"/>
(Number)	(Country)	<input type="checkbox"/>

I hereby claim the benefit under 35 U.S.C. Section 119(e) of any United States provisional application(s) listed below:

55 N/A

(Application Serial No.)

(Filing Date)

(Application Serial No.)

(Filing Date)

(Application Serial No.)

(Filing Date)

I hereby claim the benefit under 35 U. S. C. Section 120 of any United States application(s), or Section 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. Section 112, I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, C. F. R., Section 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application:

PCT/DE99/03362

16 October 1999

Pending

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(Status)
(patented, pending, abandoned)

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(Filing Date)

(Status)
(patented, pending, abandoned)

(Application Serial No.)

(Filing Date)

(Status)
(patented, pending, abandoned)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (list name and registration number)

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